Again, complete correlation does not subsist only when "every single deviation of the one characteristic corresponds to a precisely equal deviation of the other" (p. 43), but whenever the deviations are in any constant proportion. This definition, moreover, ought only to be held to apply to the case where the means of arrays lie on straight lines.

We do not like the definition of correlation as a "Beziehung . . . welche bewirkt. . . ." This is not a statistical definition, and confusion arises if the word be used carelessly, sometimes in one sense and sometimes in another. The definition of the correlation coefficient on p. 54 is much better; but why does the author call it a "morphological definition"? It is purely statistical.

The statement that it is mainly correlation which maintains the type ("die Korrelation ist es hauptsächlich, welche den Typus einer Formengemeinschaft aufrecht erhält") is a very pretty error; possibly due to the fact that biologists use correlation in a more "intensive" sense than statisticians do. Statistical correlation has absolutely nothing whatever to do with the maintenance of type. The type is described by the coordinates of the mode. If X_0 be the modal size of any organ in a parent, Y_0 the modal size of the same organ in the offspring, the "type is maintained," or constant, whenever

$$X_0 = Y_0,$$

and this relation is quite independent of the correlation. The correlation between parent and offspring might be absolutely zero, *i.e.* every single parent's offspring might be a fair sample of the whole population, and yet the type might remain absolutely fixed; or, on the other hand, parent and offspring might be perfectly correlated, and yet the type change entirely. This is at least *formally* possible. Thus, in the extreme case of alternating generations A B A B . . ., there might in the statistician's sense be perfect correlation—perfect inheritance—between A and B, although A and B differ absolutely.

Of course in a work of the present kind, written chiefly for drawing attention to the work of others, one does not look for much that is original. There is a curious approximate relation given by the author between geometric mean, arithmetic mean, and standard deviation (p. 38), a relation discovered empirically and given without proof. If

G = geometric mean,
M = arithmetic mean,
σ = standard deviation,

then *approximately* in many cases

$$\sigma^2 = M^2 - G^2.$$

The relation depends solely on all deviations being small compared with the mean, and admits of a simple algebraical proof.

Amongst small points we have marked, we would like the term "individual" variation suppressed, as it is frequently misleading, and surely not equivalent to "spontaneous"; the word "variant" seems to us unnecessary and misleading in the case of continuous variation where arbitrary groupings are used; the distinction between "Rasse" and "Formeneinheit" (p. 17) (". . . erstere nothwendig in mehreren Merkmalen, letztere in einem einzigen differiren") is surely inadequate; a preliminary calculation of the mean before calculating the moments of a frequency distribution (p. 18) is quite unnecessary, as the mean is given by the first moment; and the author is unfortunately in error in ascribing to the present writer (p. 52) the extension of the formulæ of correlation to several variables.

We regret that this notice has had to be for the most part fault-finding, as the author has undertaken a useful and somewhat thankless task, and we believe that, notwithstanding our criticisms, the pamphlet will be useful in extending a knowledge of the statistical method in Germany. There is a bibliography of 111 items at the end of the pamphlet, a feature which will render it useful to English readers as well as German. We are, of course, in sympathy with the author's aim, and hope he may have the opportunity of revising some of the points we have noted in a second issue. G. U. Y.

TEXT-BOOKS OF PHYSICS.

Physics, Experimental and Theoretical. By R. H. Jude and H. Gossin. Pp. xiii + 926. (London: Chapman and Hall, Ltd., 1899.)

THE increasing study of science in schools has been the cause of a considerable crop of text-books of elementary physics, but there is still the want of a more advanced book on the subject. This want Mr. R. H. Jude has endeavoured to supply, and as far as can be judged by a glance through his book, supplemented by a more careful examination of a few chapters, he has succeeded in giving us what promises to be a very useful work both to teachers and students. Experience only can show whether he has hit on the right standard of difficulty, and whether the learner will find the explanations sufficiently clear and complete; but there seems no reason to doubt it, considering that the work is an English adaptation of a book by Prof. Gossin, which is apparently much used in France.

Originally intended to be a translation, the volume before us contains many new articles and chapters, and the translated portions have been amplified. The first volume treats of mechanics, heat and sound. The following remarks are not intended to be special criticisms of this particular book, but rather are suggested by it and put down as matters for consideration, being of general interest to teachers of science.

It seems a little doubtful to me how far a book which contains a somewhat advanced treatment of experimental physics should enter into questions of elementary mechanics. It is impossible to believe that a student who can follow the method of treatment given in the chapters on heat in this volume should not be familiar with the parallelogram of forces, and the construction of the common pump. Some portions of dynamics, such as moments of inertia, must, of course, be included, and it may be argued that it is better to present a complete than a partial statement of mechanical principles. This is true, and of course a good deal might be said about the parallelogram of forces and velocity that is worth reading at any stage in a student's career, but what strikes me in this volume is that the standard of treatment does not quite correspond,

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and that a book which enters into questions of entropy and thermodynamic relations might pass a little more rapidly over baby mechanics. This remark applies specially to the illustrations, some of which are of the most elementary character and even childish.

This brings me to the second point I wish to submit to the consideration of authors. A number of illustrations in modern books seem to me to be put in for the sake of interrupting the text by a picture rather than for the sake of explanation. There is, for instance, the usual illustration which pretends to illustrate the fact that all bodies fall in vacuo with the same velocity. A long glass tube with a tap at the lower end, two hands holding it, and about a third of the way downward a small black dot and another dot a little bigger about a millimetre higher up. I suppose that the dots repr esent bodies, and that their closeness is intended to show their falling together. Unfortunately, in the present instance the stopcock at the bottom is open according to English ideas (though closed if they mean to be French taps), so that the intelligent student unacquainted with the habits of the French plumber would carry away the idea that bodies fall together in air at atmospheric pressure. But without laying stress on this, I should like to know the opinion of my colleagues, whether they seriously believe that students are assisted by illustrations of this nature. Some psychological freak may account for its being so; but it seems odd to me, and is worth investigating. I have marked several other instances of illustrations which seem to me to be of the same type. On the other hand, the diagrams illustrating graphic methods in thermodynamics are clear and well chosen.

Finally, I am not quite sure I like the introduction of exercises and examples. Examinations, no doubt, are a necessity, and I have no objection to books written specially to push boys through them, but the present book is too good to serve in this manner, and one does not quite like being constantly reminded of the fact that ninety-nine per cent. of students only study physics because they are obliged to do so, and I have never yet seen a student, or seen any one to my knowledge who knows a student, who will work through an example without the stimulus of examinations upon him. I should prefer to see the examples collected in a special appendix at the end. Two small points I may draw attention to, as the author may wish to correct them in another edition. Speaking of solar heat, Lord Kelvin's theory of falling meteorites is mentioned, but nothing is said about the now generally accepted theory of Helmholtz that the sun's contraction by his own gravitation is sufficient to account for the keeping up of his temperature.

Speaking of the fact that the surface of liquid at rest is a horizontal plane, the author considers it in § 127 to be a sufficient proof that the image of a plumb line is observed to be a prolongation of the line itself, for it is said that "an object and its image are symmetrical only when the reflecting surface is plain." Will not a spherical surface do equally well, if the plumb line passes through the centre of the sphere? If I add that in the figure on p. 108 the meniscus of a mercury column is wrongly drawn, inasmuch as its curvature diminishes as it approaches the glass sides, I have exhausted all the blemishes which the critical mind can discover. But I started to praise rather than to criticise, and must conclude with the hope that the volumes on light and electricity will soon be ready for publication.

ARTHUR SCHUSTER.

OUR BOOK SHELF.

The Tides Simply Explained: with Practical Hints to Mariners. By the Rev. J. H. S. Moxly, B.A., T.C.D., Chaplain to the Forces; Chaplain to Chelsea Hospital. Pp. viii + 151. (London: Rivingtons, 1899.)

THIS is a paradoxical work which may do harm owing to the standing of its author. He openly avows himself at war with the scientific world :—

"What is this strange hallucination that has taken possession of the minds of great mathematicians? I have quoted several truly absurd statements and arguments of our teachers in my first chapter. I wished to show my readers, by many infallible proofs, that the idols of authority, to which we have been bowing down, are not the correct thinkers we have supposed them to be" (p. 58).

He could not be much more severe if scientific men were a general-staff. His method of "infallible proof" of the fallibility of these idols is simple; he quotes a sentence or a paragraph, and then says:

"This is, of course, sheer nonsense! It is too absurd a statement to deserve any answer" (p. 8).

Having disposed of existing theories by this drastic process, he proceeds to give his own theory of the tides:

"The moon and earth are being drawn together by the attraction of gravity, yet they do not come together. There must therefore be a force equivalent to the force of attraction, but acting in an exactly opposite direction, which keeps the earth and moon asunder. It does not matter what we call it! 'Centrifugal force' will do for a name for it, if you like. The point for us is that the force does exist—must exist, and that it is exactly equal to the attractive force, but opposite in direction. *Well, then, if the attractive force raises a tide under the moon, the force opposite the attractive force will produce a similar effect on the opposite side of the world*" (p. 52).

The sentence in italics (which are mine) is one of the neatest things in paradox I have come across. It is scarcely surprising that the man who could invent it should be able to deduce from this amazing premiss the correct expressions for the tide-generating force at any point on the earth's surface. But then he throws this advantage to the winds, by despising the horizontal component as insignificant, and electing to work with the vertical component only, because it suggests to him an attractive but hopelessly false analogy. We are to imagine a gigantic power taking the world in its grasp, as a schoolboy would squeeze a ball between his finger and thumb. The horizontal component of tide-generating force is compared to a butterfly harnessed to Nelson's Column; but, to suit his own ideas as regards vertical force, Mr. Moxly makes the butterfly a schoolboy and Nelson's Column an india-rubber ball.

After stating this general theory, Mr. Moxly examines some cases of what have been unfortunately called "abnormal" tides, and triumphantly gives explanations of them; partly wrong, and partly such as any one could deduce from a general knowledge of the locality; and, as this is done with some skill, it is to be feared the book may mislead some of the "mariners" to whom it is addressed. It is to be hoped that before trusting Mr. Moxly they will wait until he has produced detailed and successful tide-tables for any given port deduced fairly from his own theories.

H. H. T.

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